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FLOOD INSURANCE STUDY

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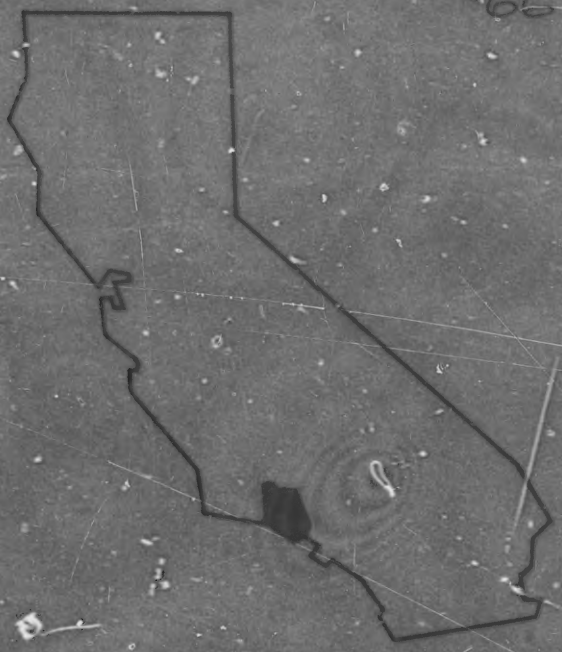

CITY OF CAMARILLO, CALIFORNIA
VENTURA COUNTY

SEPTEMBER 26, 1986

Federal Emergency Management Agency

COMMUNITY NUMBER - 065020

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Flood Boundary and Floodway Map

PUBLISHED SEPARATELY:

Flood Insurance Rate Map Index
Flood Insurance Rate Map

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FLOOD INSURANCE STUDY

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the City of Camarillo, Ventura County, California, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and assist the community in its efforts to promote sound flood plain management. Minimum flood plain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR 60.3.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the State (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were performed by PRC Toups, for the Federal Emergency Management Agency (FEMA), under Contract No. H-4032. This study was completed in May 1983.

1.3 Coordination

An initial coordination meeting was held on December 14, 1977, and attended by representatives of FEMA, the City of Camarillo, the Ventura County Flood Control District (VCFCD), and the study contractor. During this meeting, the NFIP, the Flood Insurance Study guidelines, and the scope of this study were reviewed.

Other meetings were attended by these same representatives throughout the course of the study for the purpose of data collection and to relay and review data regarding flood elevations, flood boundaries, and floodway delineations.

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An intermediate/final coordination meeting was held on December 15, 1982, and was attended by representatives of FEMA, the study contractor, the VCFCD, and the City of Camarillo. All significant problems raised at that meeting have been resolved in this study.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated areas of the City of Camarillo, Ventura County, California. The area of study is shown on the Vicinity Map (Figure 1).

Unincorporated areas of Ventura County located within Camarillo were not included in this study.

Five streams were studied by detailed methods: Calleguas and Conejo Creeks, and Camarillo Hills, Las Posas Estates, and Somis Drains. Calleguas and Conejo Creeks, along with Las Posas Estates Drain, were studied in detail for their entire length within Camarillo. Somis Drain was studied in detail from Las Posas Road downstream to its confluence with Calleguas Creek. Camarillo Hills Drain was studied in detail from Las Posas Road downstream to its confluence with Las Posas Estates Drain near Camarillo Airport.

The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development or proposed construction through May 1988.

The detailed analysis for Beardsley Wash was taken from the City of Oxnard Flood Insurance Study (Reference 1). The detailed study extends from the corporate limits upstream to a point approximately 500 feet above a drop structure.

The following streams were studied by approximate methods: Crestview, Edgemore, Lewis Road, Mission Hills, Pleasant Valley Road, Ponderosa, and West Camarillo Hills Drains.

Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon by, FEMA and the City of Camarillo.

2.2 Community Description

Camarillo is located in south-central Ventura County, in southwestern California. It is situated approximately 50 miles northwest of Los Angeles and 385 miles south of San Francisco. San Buenaventura, the county seat, is located 16 miles northwest of

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FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CAMARILLO, CA
(VENTURA CO.)

APPROXIMATE SCALE

4 0 4 8 12 MILES

VICINITY MAP

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Camarillo. The city lies within Pleasant Valley, approximately 9 miles inland from the Pacific Ocean, and is surrounded by open hills, mountains, and agricultural lands. The city covers an area of approximately 11,000 acres. Elevations within the city range from 50 feet to greater than 800 feet. Adjacent communities are the City of Oxnard to the west, the City of Thousand Oaks to the east, and unincorporated areas of Ventura County on the remaining sides.

U.S. Highway 101 (Ventura Freeway) passes through the southern part of Camarillo and connects the city with San Buenaventura, Santa Barbara, and San Francisco to the north and Thousand Oaks and Los Angeles to the south. State Highway 34 (Lewis Road) connects Camarillo with the City of Oxnard. Other major traffic arteries are Las Posas, Pleasant Valley, and Santa Rosa Roads.

The City of Camarillo had an estimated 1981 population of approximately 40,275 (Reference 2).

The economy of the area is based on agriculture, light industry, and two military bases located south of Oxnard. The Oxnard Plain and Pleasant Valley represent one of the most productive agricultural areas in the world. Ideal climate and fertile soils make the area especially suited to year-round farming and cultivation of high-valued crops. Major crops in the area are avocados, lemons, and all types of truck crops. In 1976, there were 40 industries located in Camarillo and the city had over 1,600 acres zoned for light and medium industry. The city is also an important residential community for employees of the U.S. Naval Construction Battalion Center in Port Hueneme and the Point Mugu U.S. Naval Air Station located south of Port Hueneme (Reference 3).

In 1976, the deactivated Oxnard Air Force Base, located just south of Camarillo, was opened as a local light-aircraft facility. Within 1 year, it served as the home field for more than 150 general aviation aircraft. Approximately 50 small hangars for individual aircraft were installed on the field. Growth is continuing at a rapid pace. The 760-acre facility also houses light industry, a Ventura County Sheriff's Training Academy, a high school, a community college division, and various offices for local business firms.

Development within the flood plains is strictly regulated by the VCFCD. Existing development includes residential neighborhoods, a sewage treatment plant, and an airport.

Camarillo enjoys a mild Mediterranean-type climate due to its latitude and proximity to the Pacific Ocean. Temperatures in Camarillo can be described as moderate, with the average minimum ranging from 42°F in January to 56°F in July and the average maximum ranging from 64.5°F to 74°F. The mean annual temperature in Camarillo is approximately 59°F (Reference 4).

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The average annual precipitation in the city ranges from 13 inches along Pleasant Valley Road near the Camarillo Airport to 14 inches at the extreme northeastern corner of the city (Reference 5). Generally, the rainfall season extends from November through April, with approximately 95 percent of the annual rainfall occurring during that period.

Vegetation consists mainly of scrub, brush, and weeds in the flood plain. Due to the semiarid climate, there are few indigenous trees and bushes in Camarillo; most vegetation within the city has been transplanted from other areas.

There are a variety of soil types in the city; the predominant type is a sandy soil. The soil in Camarillo is well drained and fertile.

Runoff in the Camarillo area is typical of a majority of streams and drainage systems in southern California. Streamflow is negligible other than during and immediately after rains because climatic and basin characteristics are not conducive to continuous runoff. Streamflow is seasonal and, because of the absence of snowpack, diminishes rapidly at the conclusion of the winter rainfall season.

Major watercourses within the city are Calleguas Creek, Camarillo Hills Drain, Conejo Creek, Las Posas Estates Drain, Somis Drain, and Beardsley Wash. Conejo Creek and Somis Drain are tributaries of Calleguas Creek. Las Posas Estates Drain is a tributary of Camarillo Hills Drain that flows to the west and joins Revolon Slough approximately 4,600 feet west of Wood Road. The headwaters of Camarillo Hills Drain, Las Posas Estates Drain, and Somis Drain are in the Camarillo Hills, north of the city.

The two major river systems that flow through Camarillo are Calleguas and Conejo Creeks. The larger stream, Calleguas Creek, has an elongated watershed with a maximum length of approximately 30 miles and a maximum width of approximately 14 miles. Its headwaters are in the Santa Susana Mountains and it drains a total area of approximately 325 square miles at its outlet at the Pacific Ocean. Just upstream of the confluence with Conejo Creek, at the southern city boundary, the drainage area is approximately 165 square miles.

Conejo Creek is a major tributary of Calleguas Creek. Its watershed is more rounded and produces more runoff per square mile than Calleguas Creek. Conejo Creek joins with Calleguas Creek approximately 1.4 miles downstream of U.S. Highway 101 (Ventura Freeway), and its total drainage area is 76.8 square miles.

There are several minor streams within Camarillo. Five of these streams originate in the Camarillo Hills and empty into Camarillo Hills Drain. These streams are Crestview, Edgemore, Mission Hills,

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Ponderosa, and West Camarillo Hills Drains. Their respective drainage areas are 0.59, 0.59, 0.82, 0.57, and 0.72 square miles at their confluences with Camarillo Hills Drain.

Lewis Road Drain, with a drainage area of 0.79 square mile at Pleasant Valley Road, drains a small portion of southern Camarillo and empties into Calleguas Creek south of the city. Pleasant Valley Road Drain flows westerly near the southern corporate limits. It has a drainage area of 1.35 square miles at Las Posas Road and empties into Revolon Slough.

2.3 Principal Flood Problems

Three types of storms produce precipitation in the area: general winter storms, local thunderstorms, and summer tropical storms. The general winter storms, usually characterized by heavy and prolonged rainfall over a large area, normally occur during November through April. These storms originate over the Pacific Ocean and move eastward over the area. Local thunderstorms can occur at any time, but usually cover comparatively small areas. Summer tropical storms, although infrequent, have occurred in southern California, with the most recent being in September 1976. These storms are relatively large, and normally originate in the tropics, entering the area from the southeast or southwest. Tropical storms may occur in summer or early fall.

The VCFCD maintains a stream gaging station (No. 806) on Calleguas Creek above U.S. Highway 101 (Ventura Freeway). The largest recorded flood on Calleguas Creek occurred on March 1, 1983. The peak discharge reached 17,200 cubic feet per second (cfs) at the U.S. Highway 101 gaging station; this discharge is equivalent to a recurrence interval of approximately 90 years. Other peak events and estimated recurrence intervals that have occurred at this gage are as follows:

Date	Peak Discharge (cfs)	Approximate Recurrence Interval
February 16, 1980	14,000	50 Years
February 25, 1969	11,820	40 Years
March 4, 1978	9,970	30 Years

Unofficial records derived from statements by local residents indicate that large floods occurred in 1862, 1884, 1889, 1914, and 1916; the 1862 and 1884 floods were likely the largest of these unrecorded flows.

Previous studies of Calleguas Creek and its unimproved tributaries show water velocities from 1 to 12 feet per second (0.7 to 8.2

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miles per hour (mph)). Velocities greater than 3 feet per second (2.0 mph) in water deeper than 3 feet are considered hazardous.

Flood damage in the Calleguas Creek watershed generally consists of erosion and sedimentation to agricultural land, residential and business developments, transportation facilities, and channel improvements. However, in March 1983, floodflows broke through the leveed banks of Calleguas Creek in the lower reach below U.S. Highway 101 and caused an estimated $21.5 million damage to agricultural properties. The City of Camarillo estimate of damage was $160,000. Damage during the February 1980 flood totaled approximately $9 million. This occurred primarily at the Point Mugu Naval Air Station, which was directly in the line of the floodwaters that had breached the Calleguas Creek levees. In addition, approximately 1,500 acres of farmland were covered by floodwaters.

The VCFCD also maintains a stream gaging station (No. 800A) on Conejo Creek above U.S. Highway 101. The largest recorded flood on Conejo Creek also occurred on March 1, 1983. The peak discharge reached 14,000 cfs at the U.S. Highway 101 gaging station; this discharge is equivalent to a recurrence interval of approximately 70 years. Other peak events and estimated recurrence intervals that have occurred at this gage are as follows:

Date	Peak Discharge (cfs)	Approximate Recurrence Interval
February 16, 1980	11,800	44 Years
March 4, 1978	9,830	33 Years
March 27, 1979	7,500	20 Years
February 9, 1976	5,740	14 Years

Flood damage in the Conejo Creek watershed generally consists of erosion and sedimentation. In March 1983, estimated damage was approximately $1 million, with approximately 75 percent of that amount estimated for debris and silt removal to restore the creek capacity. Floodflows on Conejo Creek add to damages occurring from Calleguas Creek floodflows below the confluence of the two creeks.

2.4 Flood Protection Measures

In 1981, FEMA adopted a new policy governing the treatment of earthen riverine levees under the NFIP. The policy defines ownership requirements and design and maintenance requirements that a levee must meet before it can be considered as providing protection against the 1 percent chance or 100-year flood.

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The policy's primary design requirement is the provision for a minimum freeboard allowance on all levees. Freeboard is defined as the distance between the computed water-surface elevation of a designated design flood and the top of the levee that is providing protection against this flood. This additional height allows for all of the uncertainties involved in the hydrologic and hydraulic analyses and the design and construction that cannot be fully considered in an analytical manner.

The basic freeboard requirement for all levees is 3 feet for the 100-year flood. Under certain circumstances, this will vary up to a maximum of 4.5 feet. Should a levee not qualify under the FEMA policy, the policy requires that this particular reach of a stream be analyzed and mapped assuming that the levee does not exist.

One stream within Camarillo has levees that protect a portion of the overbank area. On the southern end of the north bank of Conejo Creek, a levee is adjacent to the Leisure Village development. The freeboard requirement for this levee is 3.5 feet at the upper end of the levee, tapering down to 3 feet at the lower end. Another levee is located on the northern bank of the northern end of Conejo Creek, adjacent to the Leisure Village development. Following an initial hydraulic analysis of the channel, it was determined that both levees did not meet the freeboard requirements. As a result, flood hazards were reanalyzed under the assumption that the levees did not exist. Elevations of flood water entering the Leisure Village development from the northern end of Conejo Creek are not controlled directly by elevations on the adjacent reach of Conejo Creek. This shallow flooding was analyzed by approximate methods; therefore, no elevations or depths are presented on the maps.

Numerous channel improvements have also been made within Camarillo. The entire length of Somis Drain is a reinforced-concrete trapezoidal channel. The Lewis Road Drain has been partially improved with reaches of reinforced-concrete trapezoidal channels and a reach of 48-inch reinforced-concrete pipe. The pipe is only capable of carrying the 10-year flood. A new facility under construction along Lewis Road will have 100-year flood-carrying capacity; however, the facility will not be functional until the second unit of the project is completed. When completed, all 100-year flooding will be contained. It is not known when the second unit will be installed; therefore, its effects are not included in this study. Camarillo Hills Drain is a reinforced-concrete channel from its lower crossing of Las Posas Road to the upstream limit of detailed study. The channel has also been recently improved from its confluence with Revolon Slough to a point approximately 2,000 feet upstream. Mission Hills Drain has also been improved. It is a reinforced-concrete-lined trapezoidal channel from its confluence with Camarillo Hills Drain to the upstream limit of detailed study. West Camarillo Hills Drain is a reinforced-concrete trapezoidal channel from its

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confluence with Camarillo Hills Drain upstream to Las Posas Road. Edgemore Drain is a reinforced-concrete channel from its confluence with Camarillo Hills Drain upstream to Las Posas Road; upstream of Las Posas Road, the drain is a natural channel. Crestview Drain has been improved with reinforced-concrete pipe in the upper section and a reinforced-concrete box conduit in the lower section. Las Posas Estates Drain is a reinforced-concrete trapezoidal channel from the U.S. Highway 101 crossing upstream to Central Avenue. Ponderosa Drain has been improved from its confluence with Camarillo Hills Drain to its upstream study limit. This section is a combination of both a reinforced-concrete trapezoidal channel and a length of reinforced-concrete box.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1 percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for each flooding source studied in detail affecting the community.

Peak discharges for Calleguas and Conejo Creeks were taken from a hydrology report prepared by the U.S. Army Corps of Engineers for use in a special flood hazard study of that area (Reference 6).

Peak discharges for the remaining streams except Beardsley Wash were computed by the study contractor using the U.S. Army Corps of Engineers HEC-1 computer program (Reference 7). The program was

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used in conjunction with 50-year rainfall intensities developed by the VCFCD to compute 50-year peak flow rates. U.S. Geological Survey 7.5-minute series topographic maps (Reference 8) were used in the hydrologic analysis. However, many areas of Camarillo have experienced dynamic growth since the most recent topographic map revision; therefore, it was necessary to update the topographic maps in the field to ensure that developed areas used in this study conformed to present conditions. Effective impervious percentages were compared to the ratio of urbanized land to drainage area for each developed area using Figure 2 in Digital Simulation of the Effects of Urbanization on Runoff in the Upper Santa Ana Valley, California (Reference 9).

Using the 50-year flow as a base, discharges for the 10- and 100-year recurrence intervals were then computed using ratios established from regionalized equations developed by the U.S. Geological Survey and described in Magnitude and Frequency of Floods in California (Reference 10). Discharges for the 500-year event were estimated using a 500-year/100-year peak flow ratio developed from frequency tables for nearby long-term stream gaging stations computed by the U.S. Army Corps of Engineers and the VCFCD. The frequency tables were computed using techniques outlined in U.S. Water Resources Council Bulletin 17 (Reference 11).

Peak discharges for Beardsley Wash were calculated using the U.S. Army Corps of Engineers HEC-1 computer program (Reference 7). This analysis was performed for the City of Oxnard Flood Insurance Study (Reference 1).

Peak discharge-drainage area relationships for Camarillo are shown in Table 1.

The discharges presented have been reviewed by the City of Camarillo, the VCFCD, the U.S. Army Corps of Engineers, and the U.S. Geological Survey.

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

Water-surface elevations for Calleguas Creek, Camarillo Hills Drain, Conejo Creek, Las Posas Estates Drain, and Beardsley Wash were computed using the U.S. Army Corp of Engineers HEC-2 step-backwater computer program (Reference 12). At selected locations, primarily at crossings (bridges), hand calculations were made to supplement the analysis.

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Table 1. Summary of Discharges

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Calleguas Creek					
At Seminary Road	160.4	4,900	14,000	19,000	40,000
Upstream of Confluence With Conejo Creek	165.3	4,900	14,000	19,000	40,000
Camarillo Hills Drain					
Downstream of Las Posas Road	0.76	150	400	540	1,000
Upstream of Ponderosa Drive	1.16	270	740	1,000	1,900
Downstream of Mobile Avenue	1.73	750	1,040	1,390	2,600
Downstream of Confluence With Crestview Drain	5.25	900	2,650	3,620	6,800
Upstream of Confluence With Las Posas Estates Drain	7.34	930	2,830	3,920	7,400
Upstream of Confluence With Revolon Slough	9.98	1,200	3,780	5,250	9,900
Conejo Creek					
At U.S. Highway 101 Bridge	71.2	4,400	13,000	20,000	40,000
At Confluence With Calleguas Creek	76.8	4,500	14,000	21,000	42,000
Las Posas Estates Drain					
Upstream of Central Avenue	1.88	310	980	1,360	2,600
Upstream of Confluence With Camarillo Hills Drain	2.50	380	1,240	1,710	3,200
Somis Drain					
Upstream of Las Posas Road	0.37	90	260	350	700
Downstream of Ponderosa Drive	1.53	280	820	1,100	2,100
Upstream of Confluence With Calleguas Creek	2.02	320	950	1,290	2,400
Beardsley Wash					
Above Wright Road	14.0	2,300	5,000	6,800	12,000

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On Somis Drain, which is an improved channel, the HEC-2 program proved impractical; hand calculations using Manning's equation and equilibrium equations (pressure-momentum) were utilized instead.

Cross sections for the majority of the hydraulic analyses were taken from topographic maps at a scale of 1:2,400, with contour intervals of 2 and 5 feet (Reference 13). These maps were developed by the Ventura County Department of Public Works using photogrammetric methods from photography taken at various times since 1967. In areas where there had been substantial cross sectional changes due to development not reflected on the existing topographic maps or significant scour or deposition within the study reach, field-surveyed cross sections and improvement plans were used to supplement the mapping.

A field survey was also conducted on Conejo Creek in December 1979 to determine the current profile of the channel from U.S. Highway 101 to a point approximately 8,600 feet upstream. The surveyed profile was in some instances lower and at other points higher than the 1:2,400-scale mapping indicated. The hydraulic analysis of the channel was based on this surveyed profile. All other topographic data along this reach were obtained from existing topographic mapping (Reference 13) and from improvement plans of the adjacent housing development (Reference 14).

Cross sections for all streams studied in detail were located at close intervals above and below bridges and culverts to compute the significant backwater effects of these structures. All bridges and culverts were field surveyed to obtain elevation data and to define their geometric configuration.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 2).

Roughness coefficients (Manning's "n") used in the computations by both the HEC-2 program and hand calculations were assigned on the basis of field investigation of the flood plain areas and previous studies by the U.S. Army Corps of Engineers and the VCFCD. A tabulation of Manning's "n" values used in the analyses are shown in Table 2.

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Table 2. Manning's Roughness Coefficients

Stream	Channel	Overbank
Calleguas Creek	0.030-0.035	0.040-0.090
Camarillo Hills Drain	0.015-0.040	0.030-0.040
Conejo Creek	0.025-0.030	0.040-0.100
Las Posas Estates Drain	0.015-0.050	0.040-0.070
Somis Drain	0.012-0.014	No overbank condition

Starting water-surface elevations for all detailed-study streams except Conejo Creek were determined by the slope-area method; for Conejo Creek, the water-surface elevation at its confluence with Calleguas Creek was used.

Due to the nature of flooding on Somis Drain and Las Posas Estates Drain downstream of Central Avenue, flood profiles were not shown for these areas.

At a number of locations throughout the study area, the channel flow exceeded the banks and caused sheetflow in the overbank areas. Sheetflows are unpredictable, determined strictly from local topography, and do not lend themselves to HEC-2 backwater analysis. As such, the sheetflow depths were determined by hand calculations.

Debris potential was considered in the analysis throughout the study area. Current policies of the U.S. Army Corps of Engineers, Hydrologic Engineering Center, and the U.S. Army Corps of Engineers, Los Angeles District, were evaluated and considered in establishing criteria for this study.

Based on data supplied by the U.S. Army Corps of Engineers and the study contractor's own experience, criteria were adopted for consideration of the debris potential in the streams studied. The debris potential for each stream was classified as either high, medium, or low, based on historic flood data, an analysis of the characteristics of the drainage area, and a field investigation of the flooding source by hydraulic engineers. On streams with low debris potential, no provision for debris was made in the hydraulic analysis. For stream reaches where the debris potential was determined to be medium, the bridge geometry was altered using the following criteria:

1. At all reinforced-concrete box culverts and bridge crossings where the cross section end area was 100 square feet or less, the pier widths were doubled. Where the crossing consisted of two or more circular pipes, the cross section end area was reduced by 20 percent.

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2. At all bridge crossings with cross section end areas between 100 and 250 square feet, 1 foot of width was added to each side of each pier.

3. At all bridges with cross section end areas greater than 250 square feet, 2 feet of width was added to each side of each pier.

For stream reaches where the debris potential was determined to be high, the bridge geometry was adjusted by the same criteria listed above; in addition, peak discharges were bulked by a factor from 1.1 to 1.5, based on an individual analysis of the flooding source.

Debris potential in the improved channels was considered light and, at some locations, nonexistent. For example, at Somis Drain and Las Posas Road, the channel consists of two side drains running parallel to the road that merge and cross Las Posas Road via a double box culvert at supercritical slopes. Debris cannot impact the pier because flows enter the box from the sides. As such, the debris potential increased downstream and the piers at Flynn Road were considered wider than their constructed width. Field observations confirmed the collection of debris in this reach.

At no point was it assumed, or field verified, that debris would completely plug culverts in improved channels. An unimproved culvert near Camarillo Drive on West Camarillo Hills Drain, north of the city, is plugged and was considered to remain that way.

Although debris was not considered to be a problem for improved channels, some crossings do present problems, albeit minor ones. These are as follows: the Coe Street crossing of West Camarillo Hills Drain; the Aileen Street crossing of Edgemore Drain; and the Flynn Road, Lewis Road, Stiles Avenue, and Shepherd Drive crossings of Somis Drain. In the channels listed above, the storm flows remain within the channel until reaching bridges that were constructed years after the channel construction. Generally, the flooding resulting from these restrictions is confined to roadways; however, the Coe Street crossing did cause some overland flooding.

Water-surface elevations for approximate-study streams were based on hand calculations or an HEC-2 backwater analysis supplemented with hand calculations.

The hydraulic analysis for Beardsley Wash was performed for the Flood Insurance Study for the City of Oxnard (Reference 1). Water-surface elevations were computed using the U.S. Army Corps of Engineers HEC-2 step-backwater computer program (Reference 12).

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Cross section data were obtained from topographic maps (References 13 and 15). Starting water-surface elevations were determined by the slope-area method. Manning's "n" values ranged from 0.025 to 0.060.

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks used in this study are shown on the maps.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study produces maps designed to assist communities in developing flood plain management measures.

4.1 Flood Boundaries

To provide a national standard without regional discrimination, the 1 percent annual chance (100-year) flood has been adopted by FEMA as the base flood for flood plain management purposes. The 0.2 percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the 100- and 500-year flood plain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:2,400, with contour intervals of 2 and 5 feet (Reference 13).

Flood plain boundaries in Leisure Village along Conejo Creek were based on as-built plans for Leisure Village at a scale of 1:480 (Reference 14).

On Beardsley Wash, the 100- and 500-year flood plain boundaries were delineated using topographic maps at a scale of 1:2,400, with contour intervals of 2 and 5 feet (Reference 13).

For the stream channels designated "Zone A Contained in Channel," which include Las Posas Estates Drain downstream of Central Avenue and all of Somis Drain, the 100-year flood plain boundaries are based on the existing channel alignment and right-of-way.

The 100- and 500-year flood plain boundaries are shown on the Flood Boundary and Floodway Map (Exhibit 2). In cases where the 100- and 500-year flood plain boundaries are close together, only the 100-year flood plain boundary has been shown. Small areas within the flood plain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

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For the approximate-study streams, flood plain boundaries were delineated using topographic maps at a scale of 1:2,400, with contour intervals of 2 and 5 feet (Reference 13) and field inspection notes.

Approximate 100-year flood plain boundaries in some portions of the study area were taken directly from the Flood Hazard Boundary Map (Reference 16).

For streams studied by approximate methods, only the 100-year flood plain boundary is shown.

4.2 Floodways

Encroachment on flood plains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood plain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent flood plain areas, that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways presented in this study were developed through a series of procedural steps that included:

1. Evaluation of equal-conveyance reduction from each side of the flood plain

2. Negotiation and coordination with local and regional agencies

3. Review of existing hydraulic data

4. Analysis of existing floodway zoning by the community

5. Consideration of design criteria of existing and proposed structural improvements

6. Consideration of the topography and the accessibility of flood fringe areas

The results are tabulated at selected cross sections for each stream segment for which a floodway is computed (Table 3).

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Calleguas Creek								
A[2]	49,174				128.5			
B[2]	51,079				136.4			
C	52,959	133	1,544	10.7	148.4	148.4	149.4	1.0
D	55,853	140	1,155	16.5	172.7	172.7	172.7	0.0
E	58,002	299	2,312	8.2	181.2	181.2	181.9	0.7
F	60,747	430	2,705	7.0	189.7	189.7	190.6	0.9
G	63,002	250/215[3]	1,530	12.4	202.0	202.0	202.0	0.0

[1]Feet Above Pacific Ocean [2]No Floodway Computed for This Cross Section [3]Width/Width Within Corporate Limits

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CAMARILLO, CA
(VENTURA CO.)

FLOODWAY DATA

CALLEGUAS CREEK

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Camarillo Hills Drain								
A	6,000	240	1,387	2.8	60.9	60.9	61.8	0.9
B	7,950	230	841	4.7	63.2	63.2	63.9	0.7
C	10,000	240	942	4.2	69.2	69.2	70.1	0.9
D	12,000	225	717	4.9	75.6	75.6	75.7	0.1
E	14,580	120	482	7.3	82.6	82.6	83.5	0.9
F[2]	18,281				102.5			
G[2]	21,366				117.2			
H[2]	24,706				134.9			
I[2]	27,250				143.9			
J[2]	30,696				161.8			

[1] Feet Above Confluence With Revolon Slough

[2] No Floodway Computed For This Cross Section

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TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CAMARILLO, CA
(VENTURA CO.)

FLOODWAY DATA

CAMARILLO HILLS DRAIN

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
						(FEET NGVD)		
Conejo Creek								
A	5,028[1]	1,085[2]	4,886	4.3	103.5	103.5	104.0	0.5
B	6,218[1]	993/450[3]	4,974	4.2	105.2	105.2	105.8	0.6
C	7,133[1]	1,192	5,987	3.5	106.2	106.2	107.0	0.8
D	8,358[1]	1,085	4,147	5.1	107.0	107.0	107.5	0.5
E	9,573[1]	1,500	7,531	2.8	108.6	108.6	109.3	0.7
F	10,453[1]	610	3,252	6.5	108.6	108.6	109.3	0.7
G	11,578[1]	240	1,756	12.0	110.9	110.9	111.3	0.4
H	12,328[1]	420	3,308	6.3	113.7	113.7	114.4	0.7
I	13,428[1]	810	7,074	3.0	114.8	114.8	115.6	0.8
J	14,508[1]	1,295	8,314	2.5	114.9	114.9	115.9	1.0
K	15,825[1]	416[3]	5,080	3.9	116.7	116.7	117.2	0.5
L	17,970[1]	321/170[3]	4,124	4.8	117.9	117.9	118.6	0.7
M	20,250[1]	244/115[3]	2,226	9.0	119.0	119.0	119.9	0.9
N	21,790[1]	249/125[3]	2,355	8.5	123.1	123.1	123.4	0.3
O	23,860[1]	239/100[3]	2,075	9.6	131.0	131.0	131.0	0.0
P	25,510[1]	420/175[3]	1,852	10.8	136.7	136.7	136.7	0.0
Las Posas Estates Drain								
A	11,650[4]	60	172	4.7	121.4	121.4	122.0	0.6
Beardsley Wash								
A	48,400[1]	130	966	7.0	149.0	149.0	149.0	0.0

[1]Feet Above Confluence With Calleguas Creek [2]Floodway Lies Entirely Outside the Corporate Limits

[3]Width/Width Within Corporate Limits [4]Feet Above Confluence With Camarillo Hills Drain

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CAMARILLO, CA
(VENTURA CO.)

FLOODWAY DATA

CONEJO CREEK-LAS POSAS ESTATES DRAIN-BEARDSLEY WASH

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Downstream of U.S. Highway 101 (Ventura Freeway), floodways could not be determined due to limited existing channelization, unpredictability of flow paths, and the presence of low-velocity, irregular sheetflow.

On Camarillo Hills Drain, no floodway was developed upstream of Las Posas Road because the channel is improved and is located primarily along existing roads.

A floodway was not developed for either Las Posas Estates Drain downstream of Central Avenue or Somis Drain because the flood hazard is contained within the channel.

As shown on the Flood Boundary and Floodway Map (Exhibit 2), the floodway boundaries were computed at cross sections. Between cross sections, the boundaries were interpolated. In cases where the floodway and 100-year flood plain boundaries are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and 100-year flood plain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 2.

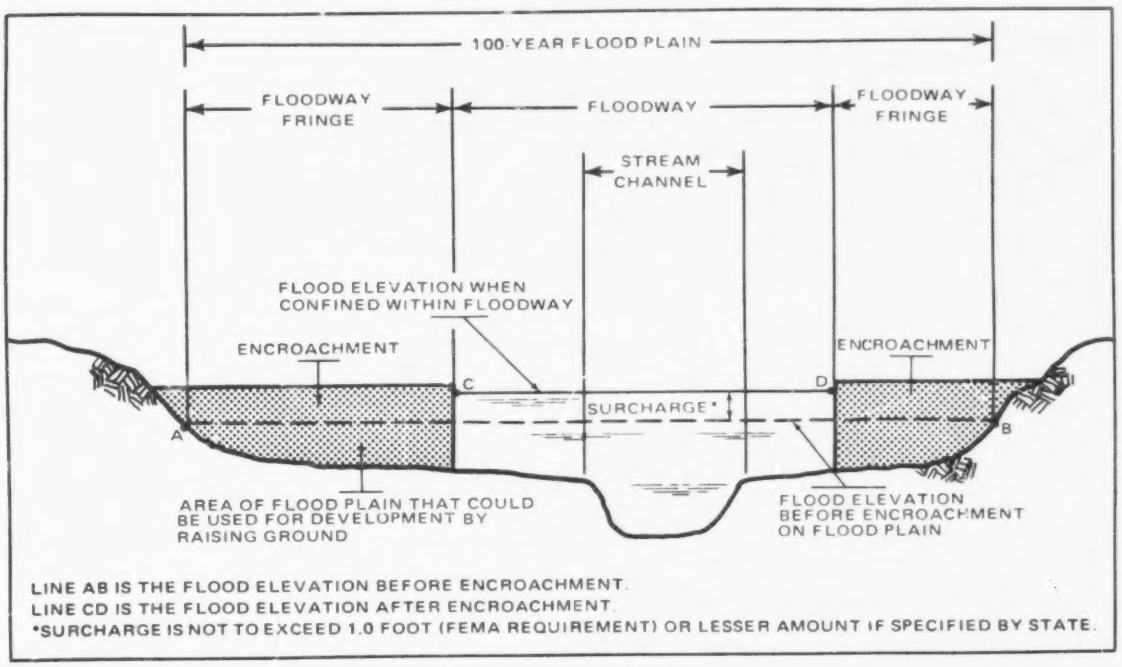
100-YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE*
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE AB IS THE FLOOD ELEVATION BEFORE ENCROACHMENT.
LINE CD IS THE FLOOD ELEVATION AFTER ENCROACHMENT.
*SURCHARGE IS NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE.

Figure 2. Floodway Schematic

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5.0 INSURANCE APPLICATION

To establish actuarial insurance rates, data from the engineering study must be transformed into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors, and flood insurance zone designations for each flooding source studied in detail affecting the City of Camarillo.

5.1 Reach Determinations

Reaches are defined as sections of flood plain that have relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference may not have a variation greater than that indicated in the following table for more than 20 percent of the reach:

Average Difference Between 10- and 100-Year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The locations of the reaches determined for the flooding sources of Camarillo are shown on the Flood Profiles (Exhibit 1) and summarized in Table 4.

For channels designated "Zone A Contained in Channel," no reach determinations were made. Reach determinations, which were made for insurance purposes, would have no relevance in a defined channel.

5.2 Flood Hazard Factors

The Flood Hazard Factor (FHF) is used to establish relationships between depth and frequency of flooding in any reach. This relationship is then used with depth-damage relationships for various classes of structures to establish actuarial insurance rate tables.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations rounded to the nearest one-half foot, multiplied by 10, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year flood water-surface elevations is greater than 10.0 feet, it is rounded to the nearest whole foot.

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FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION (FEET NGVD)[3]
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
Calleguas Creek							
Reach 1	0005	-7.9	-0.6	0.0	080	A16	Varies - See Map
Reach 2	0005	-5.5	-0.4	0.0	055	A11	Varies - See Map
Reach 3	0002,0005	-7.9	-1.4	1.9	080	A16	Varies - See Map
Reach 4	0002,0003	-5.7	-1.7	3.8	055	A11	Varies - See Map
Reach 5	0002,0003	-4.0	-1.2	3.2	040	A8	Varies - See Map
Camarillo Hills Drain							
Reach 1	0004	-1.8	-0.5	1.1	020	A4	Varies - See Map
Reach 2	0001,0002, 0004	-3.7	-1.2	1.5	035	A7	Varies - See Map
Reach 3	0002	-1.7	-0.5	1.0	015	A3	Varies - See Map

[1]Flood Insurance Rate Map Panel [2]Weighted Average [3]Rounded to Nearest Foot

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CAMARILLO, CA
(VENTURA CO.)

FLOOD INSURANCE ZONE DATA

CALLEGUAS CREEK-CAMARILLO HILLS DRAIN

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FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION (FEET NGVD)[3]
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
Conejo Creek							
Reach 1	0005,0006	-2.0	-1.0	2.2	020	A4	Varies - See Map
Reach 2	0005,0006	-3.7	-1.1	2.1	035	A7	Varies - See Map
Reach 3	0006	-7.7	-2.0	2.8	075	A15	Varies - See Map
Reach 4	0003,0006	-8.3	-2.4	3.2	085	A17	Varies - See Map
Reach 5	0003,0006	-6.0	-1.8	3.1	060	A12	Varies - See Map
Las Posas Estates Drain							
Reach 1	0001	-2.3	-0.5	0.8	025	A5	Varies - See Map
Beardsley Wash							
Reach 1	0001	-3.6	-1.4	3.5	035	A7	Varies - See Map

[1]Flood Insurance Rate Map Panel [2]Weighted Average [3]Rounded to Nearest Foot

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CAMARILLO, CA
(VENTURA CO.)

FLOOD INSURANCE ZONE DATA

CONEJO CREEK-LAS POSAS ESTATES DRAIN-BEARDSLEY WASH

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FHFs are derived from standard reach determinations; therefore, they do not apply to flooding sources designated "Zone A Contained in Channel."

5.3 Flood Insurance Zones

Flood insurance zones and zone numbers are assigned based on the type of flood hazard and the FHF, respectively. A unique zone number is associated with each possible FHF, and varies from 1 for an FHF of 005 to a maximum of 30 for an FHF of 200 or greater.

Zone A:	Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations shown or FHFs determined.
Zones A3-A5, A7, A8, A11, A12, and A15-A17:	Special Flood Hazard Areas inundated by the 100-year flood; with base flood elevations shown, and zones subdivided according to FHFs.
Zone B:	Areas between the Special Flood Hazard Areas and the limits of the 500-year flood; areas that are protected from the 100- or 500-year floods by dike, levee, or other local water-control structure; areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.
Zone C:	Areas of minimal flood hazard; not subdivided.

In this study, the channels studied by detailed methods in which the flood hazard is contained in the channel have been designated "Zone A Contained in Channel."

The flood elevation differences, FHFs, flood insurance zones, and base flood elevations for each flooding source studied in detail in the community are summarized in Table 4.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for Camarillo is, for insurance purposes, the principal product of the Flood Insurance Study. This map contains the official delineation of flood insurance zones and base flood elevations. Base flood elevation lines show the locations of the expected whole-foot water-surface elevation of the

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base (100-year) flood. The base flood elevations and zone numbers are used by insurance agents, in conjunction with structure elevations and characteristics, to assign actuarial insurance rates to structures and contents insured under the NFIP.

6.0 OTHER STUDIES

A report dealing with the flooding hazards in the Camarillo area was published by the U.S. Army Corps of Engineers, Los Angeles District.

A Special Flood Hazard Study, Calleguas Creek and Conejo Creek, Vicinity of Camarillo, Ventura County, California, was published in January 1977 (Reference 6). It was published as an update of previous studies done in that area and reflected the recent urbanization that the area had undergone. The hydrologic analysis in this study used discharge values prepared for that study.

A Flood Hazard Boundary Map has been published for the City of Camarillo (Reference 16). It is the source of some approximate flood plain boundaries used in this study. In other areas, however, this study represents a more recent and comprehensive analysis and, therefore, supersedes the Flood Hazard Boundary Map.

This study is in agreement with the Flood Insurance Studies for the unincorporated areas of Ventura County (Reference 17), the City of Oxnard (Reference 1), and the City of Thousand Oaks (Reference 18).

The flooding sources covered in the Flood Insurance Study for Ventura County that are either adjacent to or pass through the City of Camarillo are Calleguas Creek, Conejo Creek, Pleasant Valley Road Drain, and Las Posas Estates Drain. The flood plain boundaries for these sources shown for this study match those shown for the Ventura County study.

Beardsley Wash was studied by detailed methods in the Flood Insurance Study for the City of Oxnard. The hydraulic data from that study were used in this study.

Although the City of Thousand Oaks is situated on the eastern side of Camarillo, the cities have no common flooding sources. As a result, no conflicts exist in flood plain boundaries.

7.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, FEMA, Building 105, Presidio of San Francisco, San Francisco, California 94129.

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8.0 BIBLIOGRAPHY AND REFERENCES

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16. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, City of Camarillo, California, Scale 1:12,000, Revised October 24, 1975

17. Federal Emergency Management Agency, Flood Insurance Study, Ventura County, California (Unincorporated Areas), 1985

18. Federal Emergency Management Agency, Flood Insurance Study, City of Thousand Oaks, California, Revised January 3, 1983

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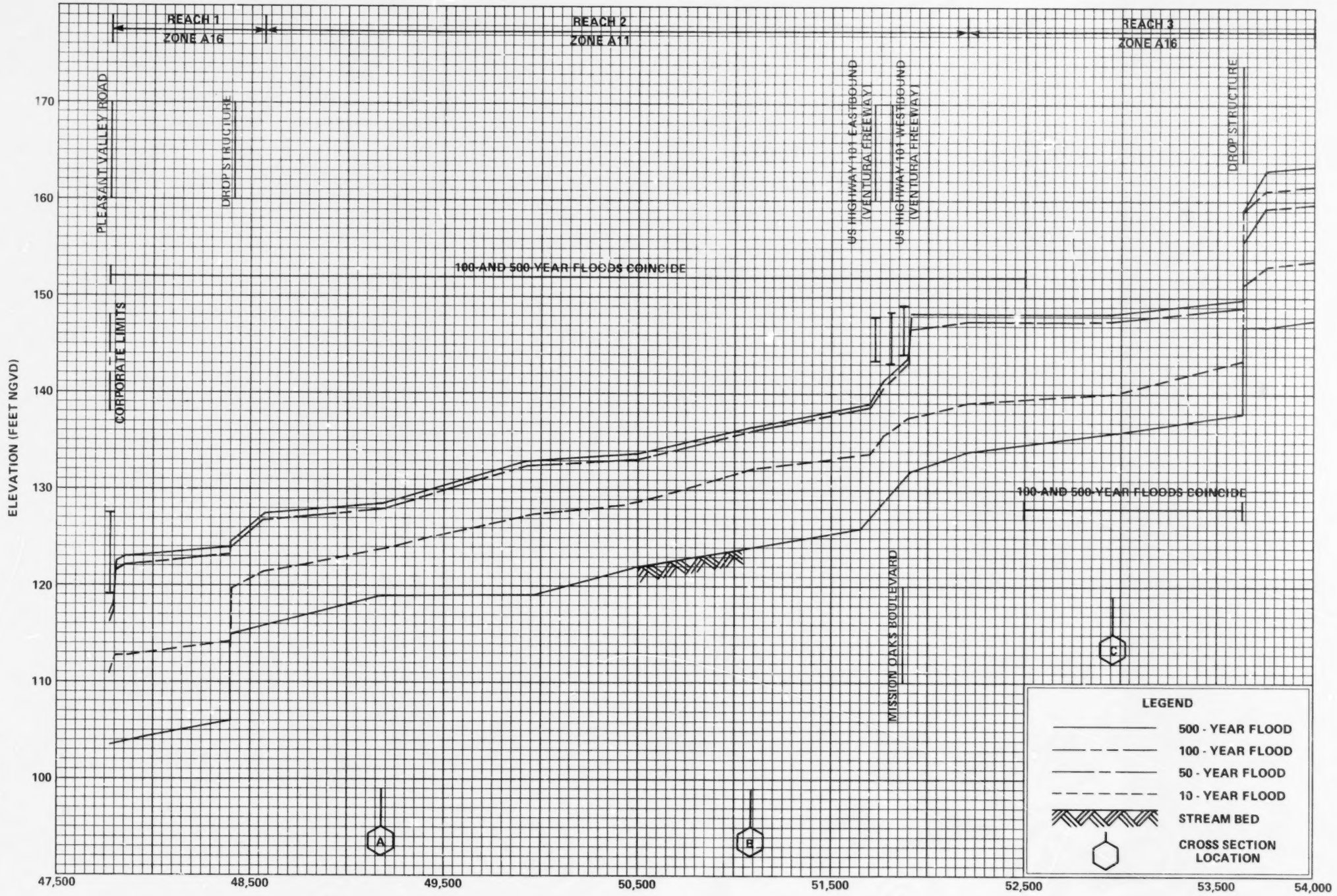

FLOOD PROFILES

CALLEGUAS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CAMARILLO, CA
(VENTURA CO.)

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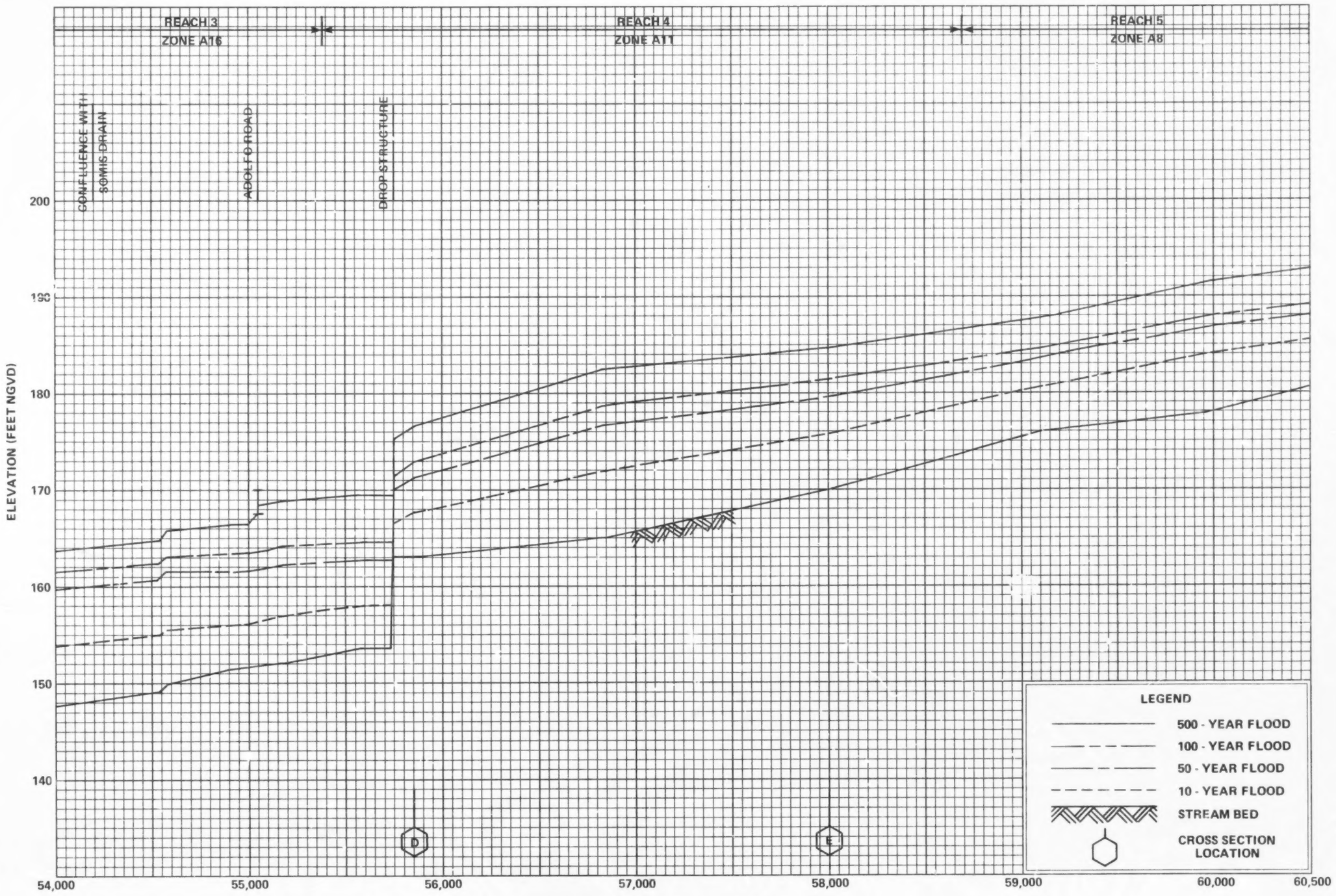

FLOOD PROFILES

CALLEGUAS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CAMARILLO, CA
(VENTURA CO.)

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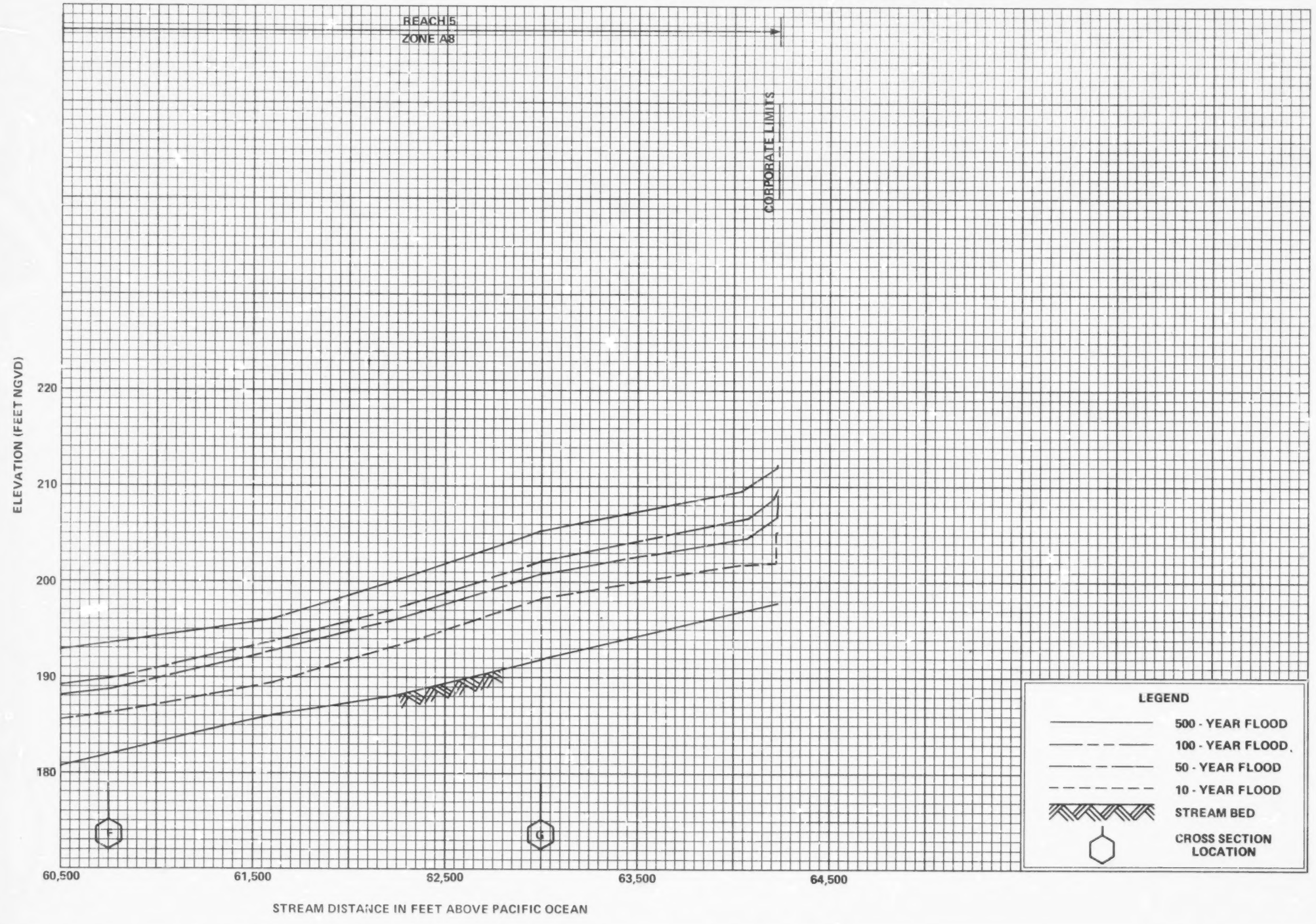

FLOOD PROFILES

CALLEGUAS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CAMARILLO, CA
(VENTURA CO.)

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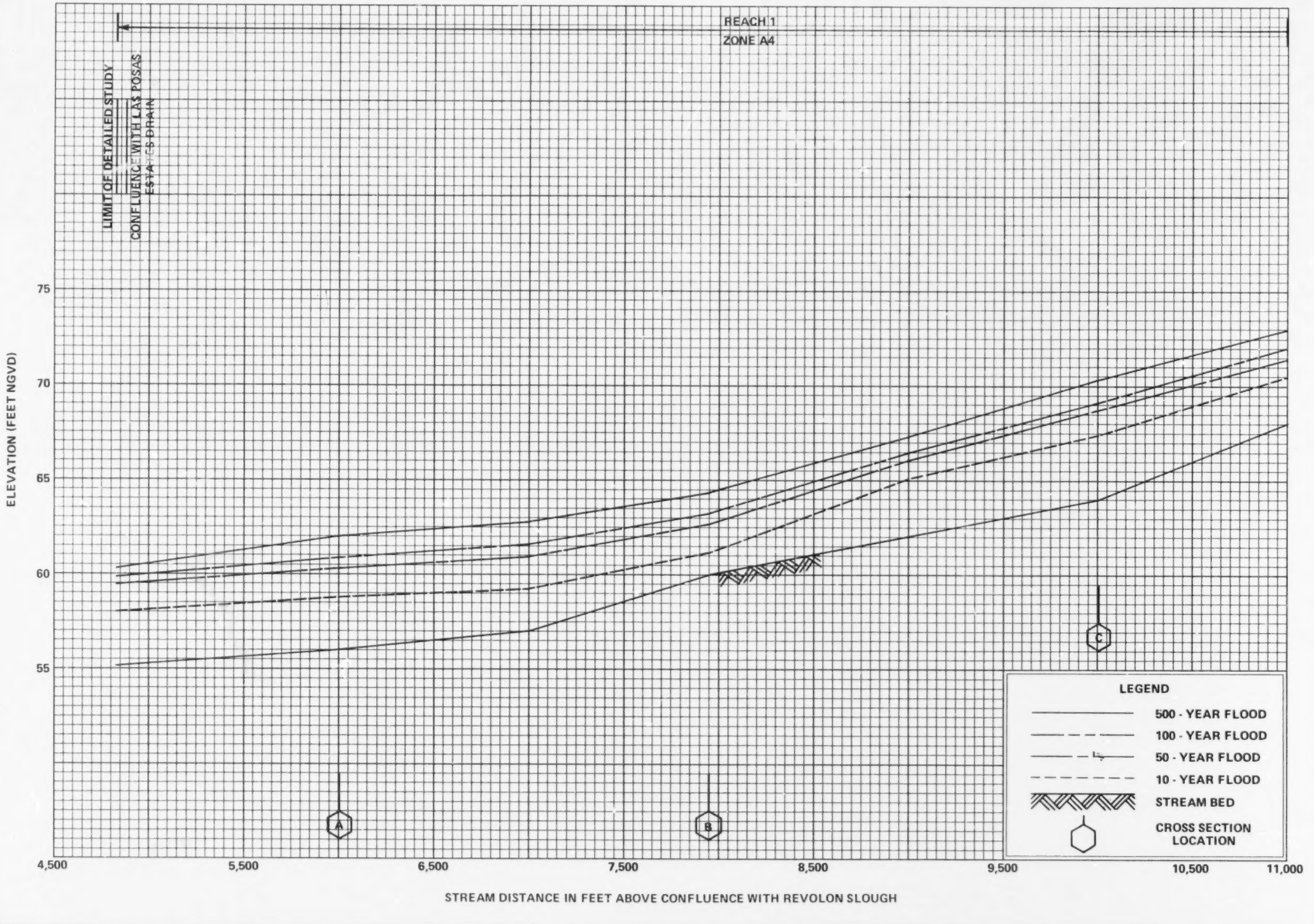

FLOOD PROFILES

CAMARILLO HILLS DRAIN

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CAMARILLO, CA
(VENTURA CO.)

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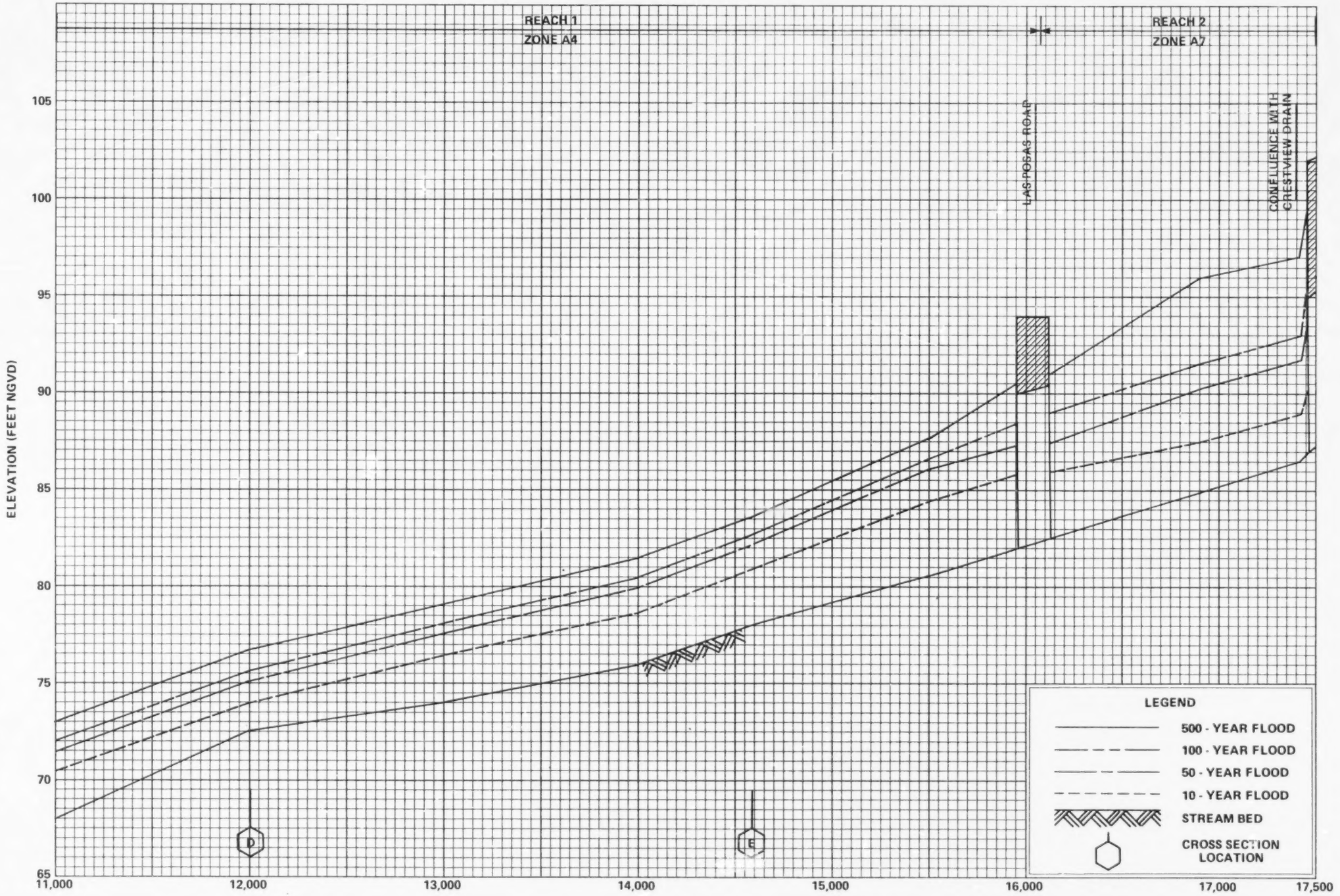

FLOOD PROFILES

CAMARILLO HILLS DRAIN

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CAMARILLO, CA
(VENTURA CO.)

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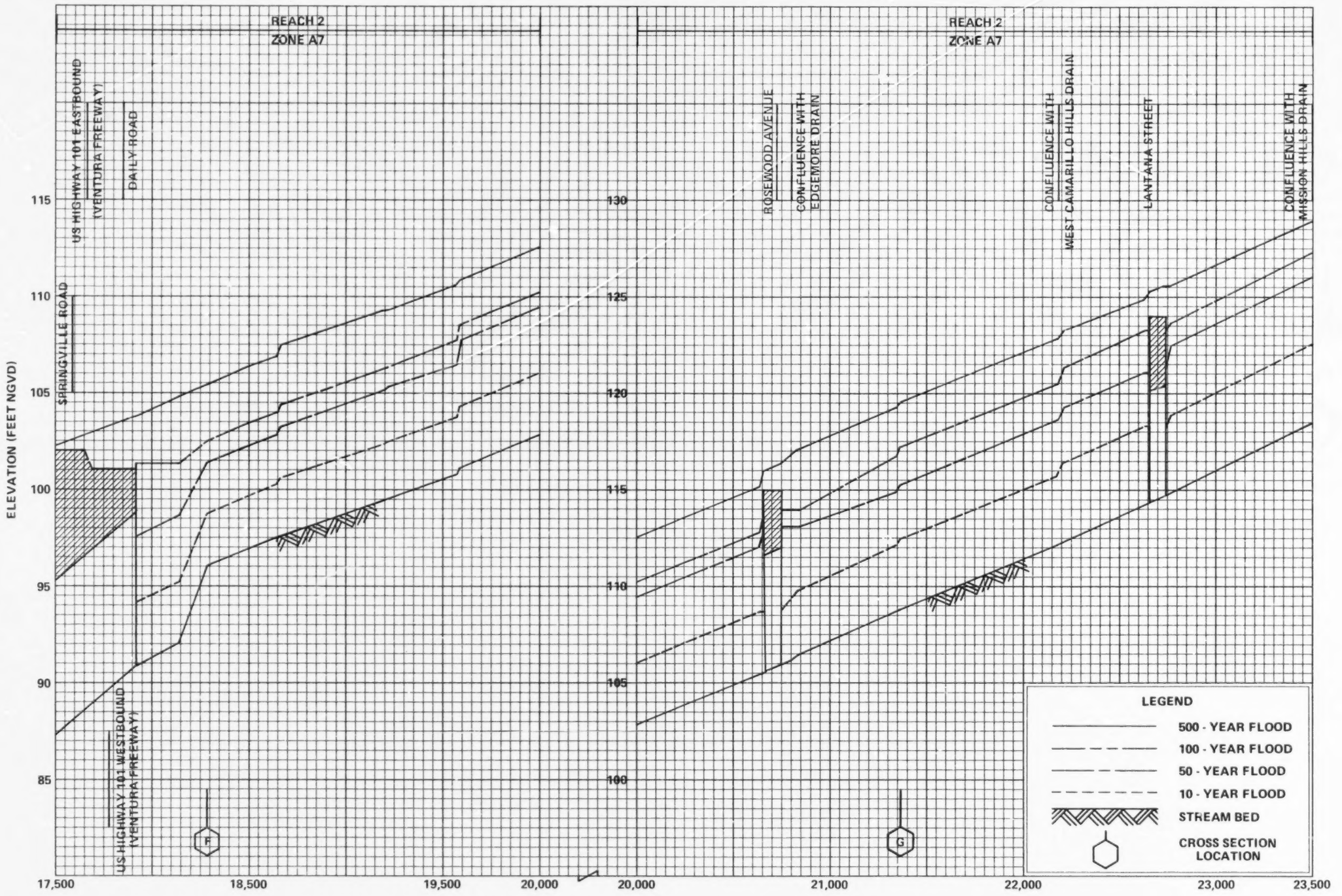

FLOOD PROFILES

CAMARILLO HILLS DRAIN

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CAMARILLO, CA
(VENTURA CO.)

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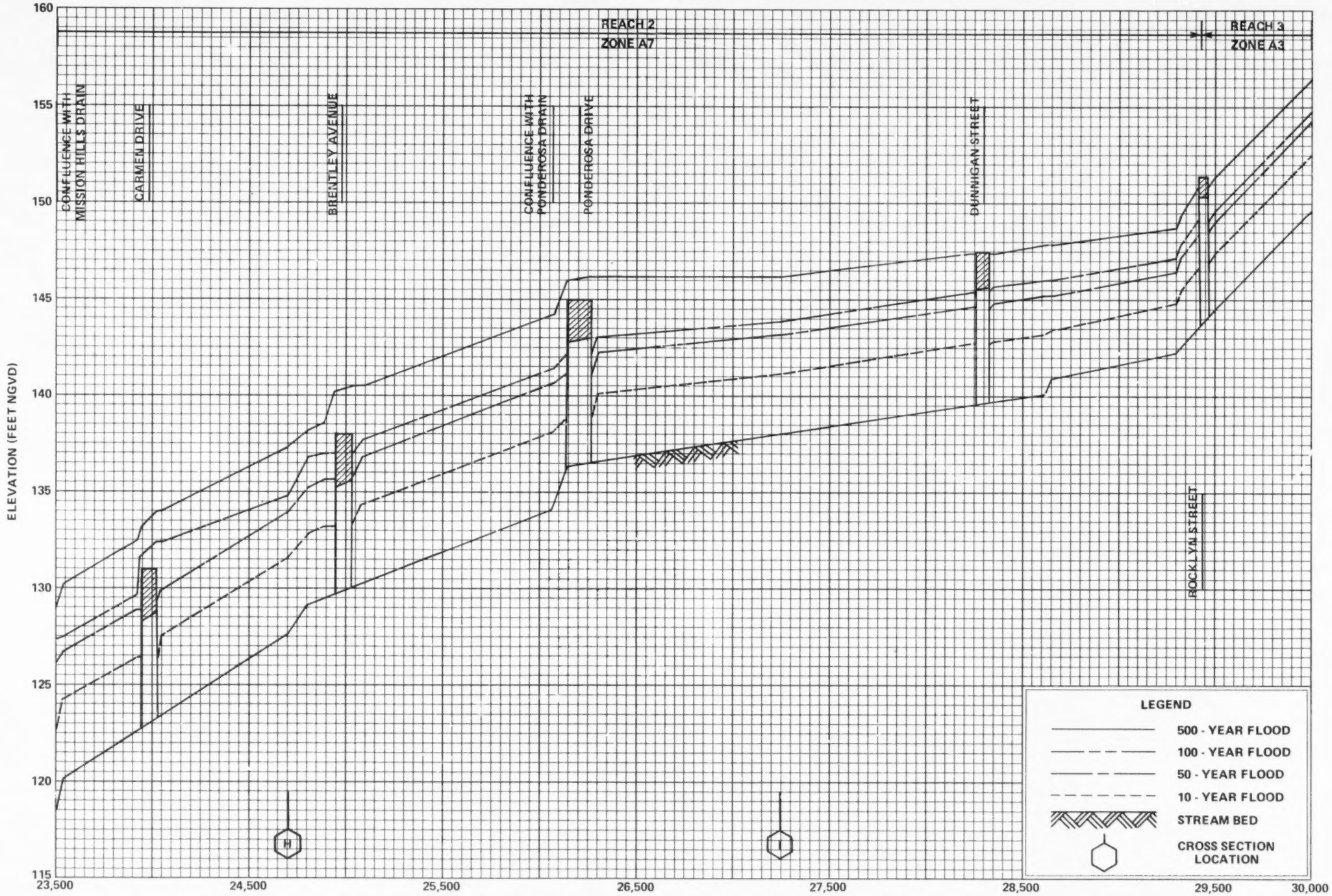

FLOOD PROFILES

CAMARILLO HILLS DRAIN

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CAMARILLO, CA
(VENTURA CO.)

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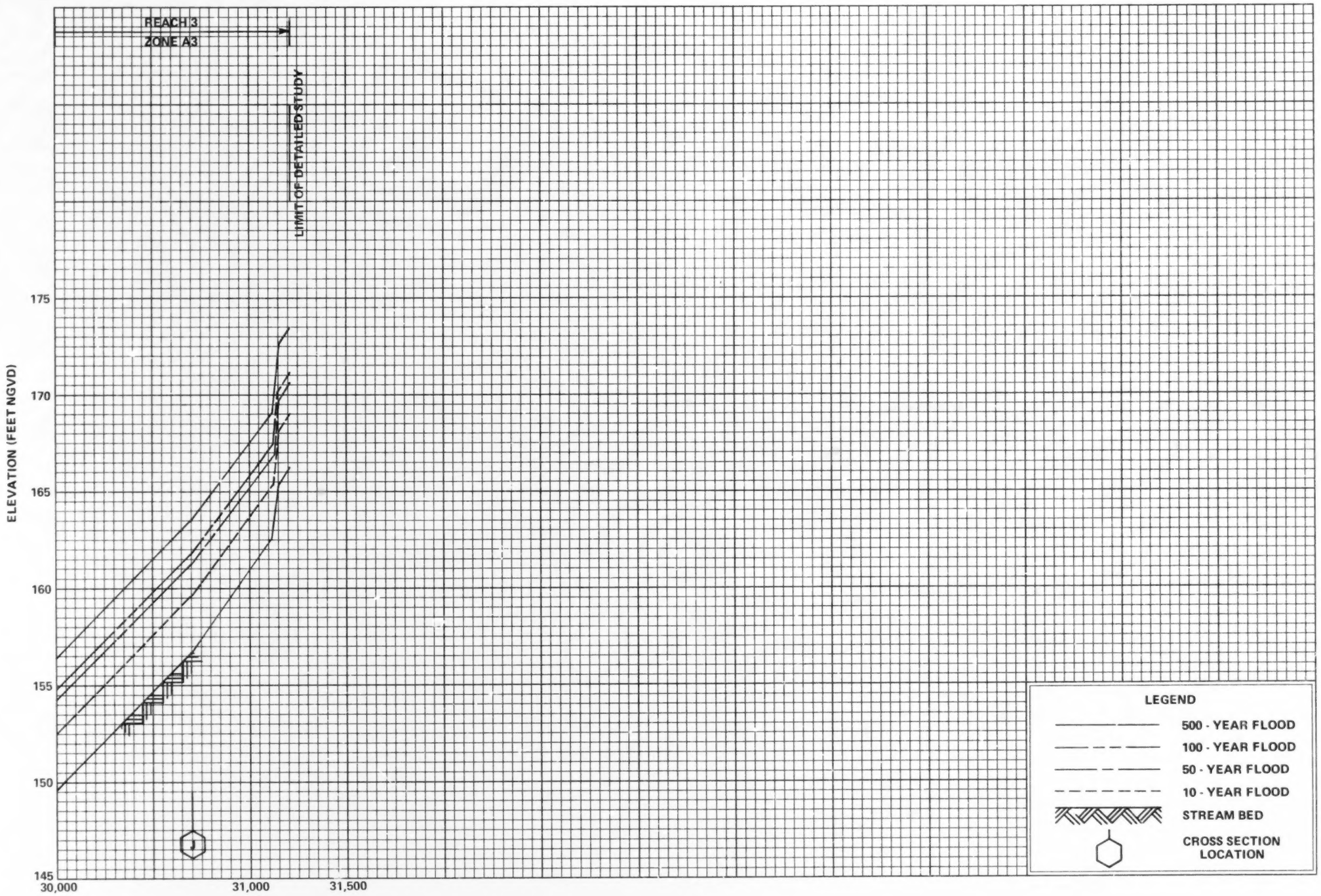

FLOOD PROFILES

CAMARILLO HILLS DRAIN

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CAMARILLO, CA
(VENTURA CO.)

08P

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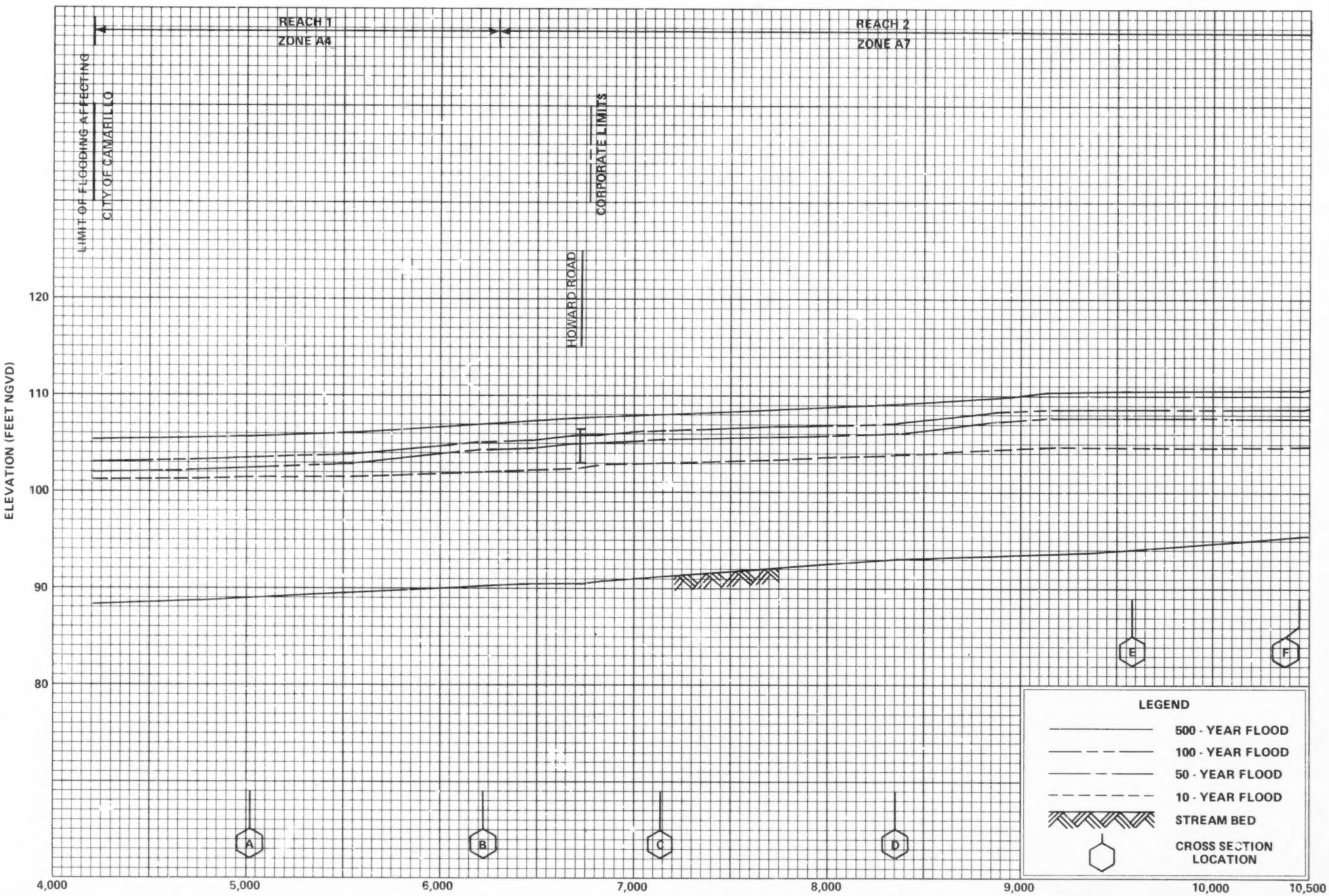

FLOOD PROFILES

CONEJO CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CAMARILLO, CA
(VENTURA CO.)

09P

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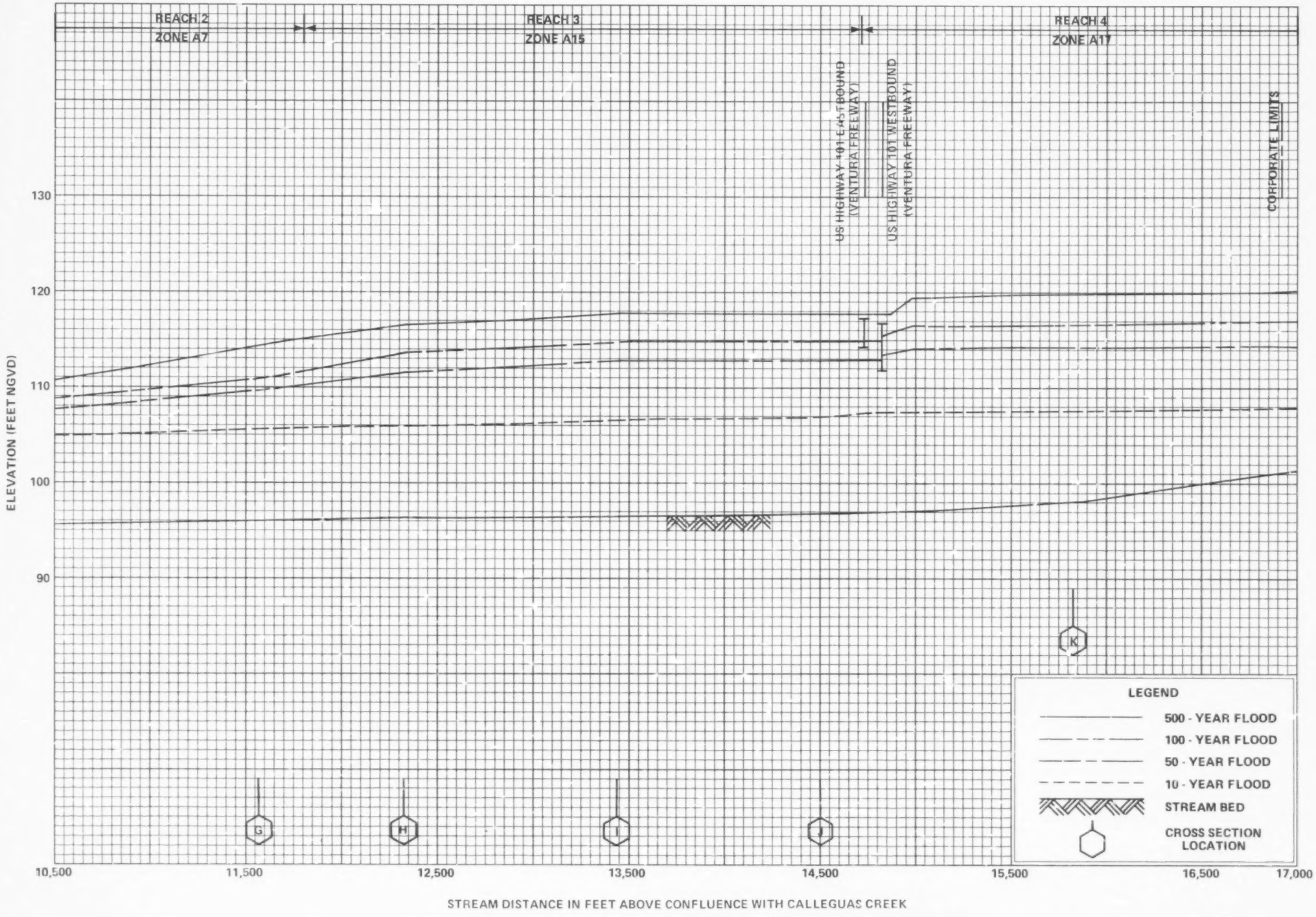

FLOOD PROFILES

CONEJO CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CAMARILLO, CA
(VENTURA CO.)

10P

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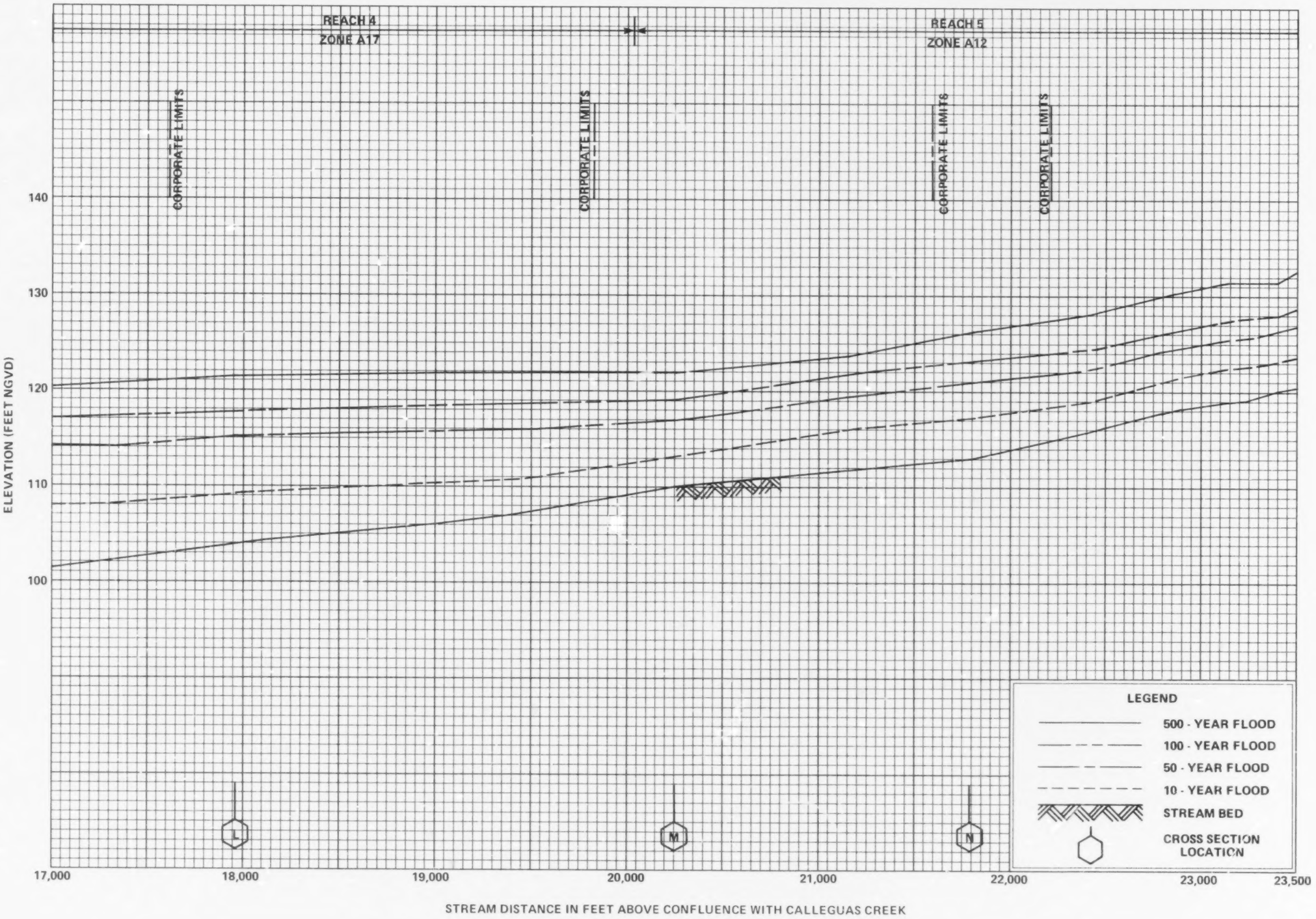

FLOOD PROFILES

CONEJO CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CAMARILLO, CA
(VENTURA CO.)

11P

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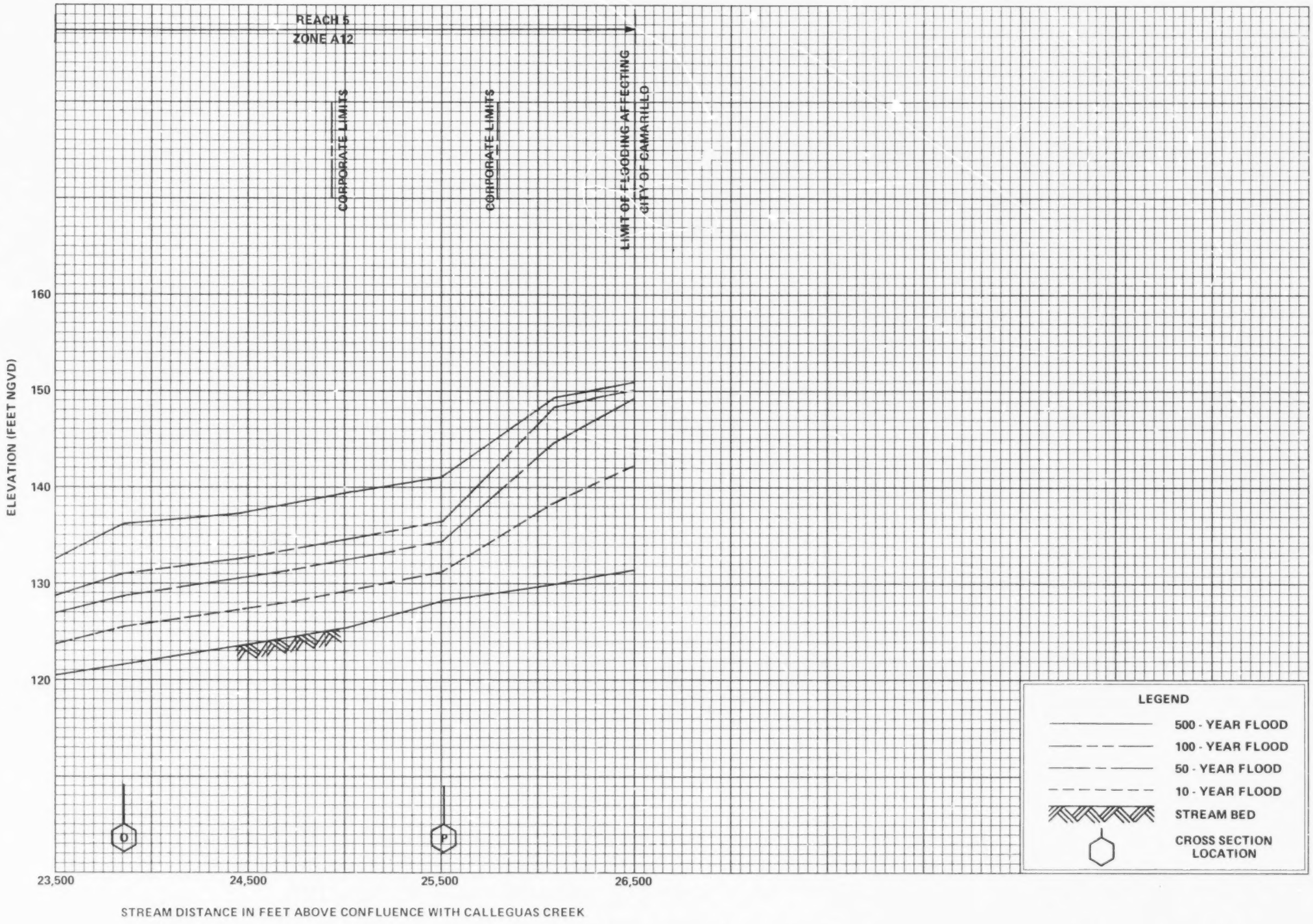

FLOOD PROFILES

CONEJO CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CAMARILLO, CA
(VENTURA CO.)

12P

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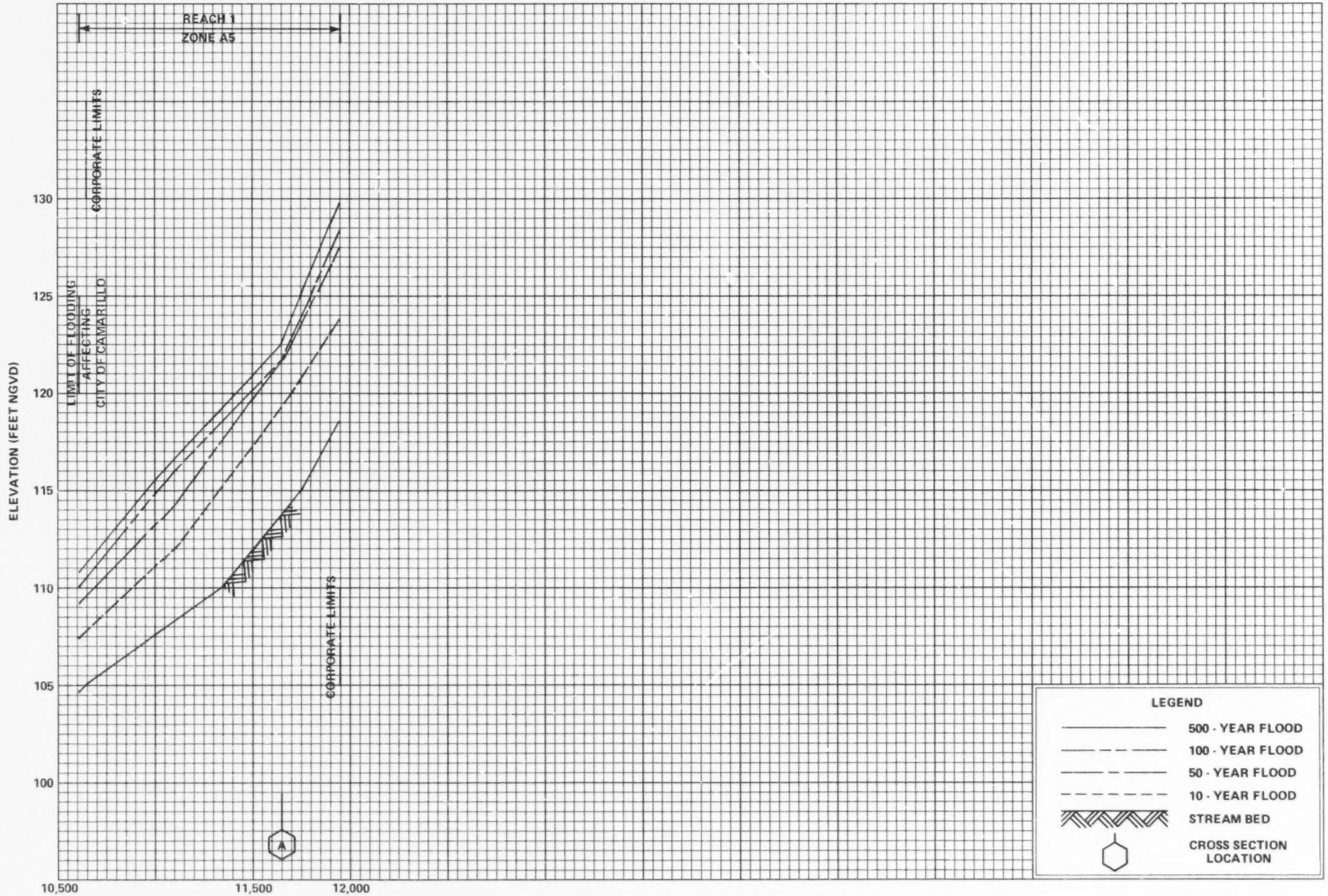

FLOOD PROFILES

LAS POSAS ESTATE DRAIN

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CAMARILLO, CA
(VENTURA CO.)

13P

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STREAM DISTANCE IN FEET ABOVE CONFLUENCE WITH CALLEGUAS CREEK

FLOOD PROFILES

BEARDSLEY WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

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(VENTURA CO.)

14P

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